Journal of Pioneering Medical Sciences
Received: February 24, 2025 | Accepted: March 28, 2025 | Published: July 05, 2025
Volume 14, Issue 06, Pages 53-59

DOI https://doi.org/10.47310/jpms2025140608

Pilot Study: Efficacy of Light Therapy on Depression, Bio Physiological and Biochemical Parameters among Adult Depressive Patients

S. Angelin Lavanya[1], N. Paarthipan[2] and S. Kalabarathi[3]

[1]Department of Mental Health Nursing, Saveetha College of Nursing, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu, India

[2]Department of Radiology, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu, India

[3]Department of Obstetrics and Gynaecological Nursing, Saveetha College of Nursing, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai, Tamil Nadu, India

Author Designation: [1]Ph.D. Scholar, [2]Professor, [3]Professor

*Corresponding author: S. Angelin Lavanya (e-mail: angelinlavanya@yahoo.com).

©2025 the Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0

Abstract Light therapy, also referred to as Bright Light Therapy (BLT), has emerged as an important intervention for depression, particularly in its application to both seasonal and non-seasonal Major Depressive Disorders (MDD). The study, approved by the institutional ethical committee, utilized a quasi-experimental design with a pretest-posttest control group. A total of 20 participants (aged 18-59) were recruited from outpatient and inpatient settings using non-probability purposive sampling. Participants were categorized into mild to severe depression, based on Beck's Depression Inventory and BMI standards. Ten participants were assigned to the experimental group and ten to the control group. Inclusion criteria required participants to be literate in Tamil and English, while exclusion criteria excluded those with ophthalmic, neurological, dermatological issues, severe psychotic disorders, critical illness, or non-cooperation. The light therapy study showed significant reductions in depression among the experimental group, with scores decreasing from 19.90 (SD = 3.78) to 14.20 (SD = 2.89), a 5.70-point drop ($t = 4.414$, $p = 0.002$). The control group showed minimal change, with scores moving from 19.00 (SD = 5.37) to 18.50 (SD = 5.58), showing no significant difference ($t = 2.236$, $p = 0.052$). Additionally, light therapy improved biophysiological parameters like pulse rate, respiratory rate, and serotonin/dopamine levels in the experimental group ($p<0.001$). The study concluded that light therapy is an effective form of treatment for reducing depression and improvements in biophysiological parameters in the experimental group highlight the effectiveness of light therapy in managing depressive disorders.

Key Words Effectiveness, Light Therapy, Adults, Depression, Patients

INTRODUCTION

Light therapy, also referred to as bright light therapy (BLT), has emerged as an important intervention for depression, particularly in its application to both seasonal and non-seasonal major depressive disorders (MDD). Recent research highlights the intricate relationship between environmental light exposure and mood regulation, suggesting that adequate light exposure can positively impact depressive symptoms. A systematic review by Seok and Kim demonstrated that light therapy is effective in reducing depressive symptoms among older adults, corroborating findings from previous studies that support light therapy as a viable treatment option for MDD across diverse populations [1].

Furthermore, studies suggest that light therapy can modulate neurophysiological responses, influencing functional connectivity in the brain and the regulation of neurotransmitters associated with mood disorders [2]. Notably, light exposure has been associated with increased serotonin production and improved sleep patterns-both critical factors in managing depression [3].

The mechanisms of action underlying light therapy are multifaceted. Research indicates that exposure to bright light can enhance the release of neurotransmitters such as serotonin and dopamine, modulating the circadian rhythms that often are disrupted in depressive patients. Beyond neurotransmitter regulation, light therapy has also shown promise in reducing agitation and improving sleep quality among those experiencing depression [4].

The implications of light therapy extend beyond merely alleviating psychological symptoms; it constitutes a non-invasive intervention that can lead to favourable biochemical changes, including alterations in melatonin levels, which are often disrupted in mood disorders [5]. Studies suggest that morning light exposure is more beneficial in synchronizing circadian rhythms and consequently improving depressive symptoms compared to evening exposure [6].

The adjunctive use of light therapy alongside pharmacotherapy, such as selective serotonin reuptake inhibitors (SSRIs), has been shown to improve patient outcomes in both seasonal and non-seasonal depression [7].

This integrative approach may facilitate more comprehensive treatment plans that address both the psychological and physiological aspects of depression. Incorporating findings from randomized controlled trials, the efficacy of combining light therapy with established pharmacological treatments has been scientifically validated, leading to nuanced treatment strategies that capitalize on the strengths of each therapeutic intervention [8].

In patients with MDD comorbid with chronic conditions such as diabetes or cardiac diseases, light therapy has shown beneficial effects not only on mood but also on health-related quality of life, thereby addressing the multidimensional nature of depression [9,10]. Moreover, advancements in neuroimaging techniques have facilitated a deeper understanding of how light therapy influences neurological structures associated with mood regulation. Research using Positron Emission Tomography (PET) has shown that light exposure can change brain activity, especially in areas that control mood. [11].

Light therapy represents an innovative and adaptable approach to managing depression, presenting compelling advantages due to its non-invasive nature and the minimal side effects associated with its application. The therapeutic implications of light therapy are profound, as it not only promises to alleviate depressive symptoms but also seeks to enhance the overall quality of life for individuals grappling with this debilitating condition.

METHODS

The study was approved by Institutional Ethical Committee. This research adopted a quasi-experimental design with a pretest-posttest control group format to investigate the effects of light therapy on adults diagnosed with depressive disorders. The study involved a total of 20 adult patients suffering from depression, categorized into mild mood disturbance, borderline clinical depression, moderate depression, and severe depression. Participants were recruited from both inpatient and outpatient psychiatric unit. A non-probability purposive sampling method was employed to select the participants. Ten patients were assigned to the experimental group and another ten to the control group, ensuring they met the inclusion criteria for depressive disorders as defined in the study. Beck's Depression Inventory was used to assess the level of depression. The light box had an intensity of 10,000 lux and was placed 16 to 24 inches (41 to 61 centimeters) from the participant's face. Light therapy was administered for one hour daily over two consecutive days. The control group received standard care only, without light therapy.

Inclusion and Exclusion Criteria

The study includes adults aged 18 to 59 with depression, assessed using Beck's Depression Inventory and categorized by BMI according to ICMR standards. Participants must be willing and able to read Tamil and English. Exclusion criteria include individuals with ophthalmic, neurological, or dermatological issues, severe psychotic disorders, critical illness, severe depression requiring urgent intervention, or those who are non-cooperative or absent during data collection. This ensures a focused and ethical study environment.

Data Collection

Initial assessments (pretests) were conducted to establish baseline measures of depression levels and biophysiological parameters such as pulse, respiration, blood pressure, height, weight, and BMI. Additionally, blood samples were collected to analyze biochemical markers such as serotonin, oxytocin, dopamine, and high-density lipoprotein. Participants in the experimental group underwent light therapy sessions lasting one hour every alternate day. Written informed consent was obtained from all participants prior to the commencement of the study. At the end of the 89-day intervention period, a post-test was conducted using the same structured interview schedule and questionnaire applied in the pretest to both the experimental and control groups to evaluate changes and compare outcomes. The study was conducted following ethical guidelines to protect the participants' confidentiality and well-being throughout the research process.

RESULTS

Demographic and Clinical variables

Table 1 presents the demographic distribution of adult depressive patients in the experimental and control groups (n = 10 each). The variables include age, gender, religion, residence, education, occupation, income, marital status, type of marriage, family type, marital duration, number of children, and dietary pattern. Chi-square analysis showed no statistically significant difference ($p>0.05$) between the groups for any variable, indicating that the experimental and control groups were demographically comparable.

There were no significant differences in clinical variables between experimental and control groups as shown in Table 2. Stressful events, duration of depression and family history of depression are alike in both groups. Hospitalization rates are also comparable.

Table 1: Distribution of demographic variables of the adult depressive patients in the experimental and control group (N = 20)

Demographic Variables	Experimental Group (n = 10)		Control Group (n = 10)		Chi-Square value for homogeneity
	F	%	F	%	
Age in years					$\chi^2 = 1.200$ p = 0.753 N.S
18-28	0	0	1	10	
29-39	5	50	5	50	
40-50	2	20	2	20	
51-60	3	30	2	20	
Gender					$\chi^2 = 0.000$ p = 1.000 N.S
Male	4	40	4	40	
Female	6	60	6	60	
Religion					$\chi^2 = 1.077$ p = 0.783 N.S
Hindu	7	70	6	60	
Christian	2	20	2	20	
Muslim	1	10	1	10	
Others	0	0	1	10	
Residential living					$\chi^2 = 0.000$ p = 1.000 N.S
Urban	7	70	7	70	
Rural	3	30	3	30	
Educational qualification					$\chi^2 = 2.429$ p = 0.488 N.S
No formal education	4	40	3	30	
Primary education	2	20	5	50	
Secondary education	3	30	1	10	
Graduate	1	10	1	10	
Occupational status					$\chi^2 = 2.400$ p = 0.301 N.S
Government employee	-	-	-	-	
Private employee	4	40	4	40	
Self employed	0	0	2	20	
Agriculture	-	-	-	-	
Unemployed/housewife	6	60	4	40	
Monthly family income					$\chi^2 = 7.683$ p = 0.053 N.S
Below Rs.2000	6	60	1	10	
Rs.2001-Rs.5000	4	40	5	50	
Rs,5001-Rs.10000	0	0	3	30	
Rs.10001-Rs.50000	0	0	1	10	
Above Rs.50000	-	-	-	-	
Marital status					$\chi^2 = 0.000$ p = 1.000 N.S
Unmarried	2	20	2	20	
Married	7	70	7	70	
Separated/Divorced	1	10	1	10	
Type of marriage					$\chi^2 = 0.000$ p = 1.000 N.S
Consanguineous	2	20	2	20	
Non-consanguineous	8	80	8	80	
Type of family					$\chi^2 = 0.000$ p = 1.000 N.S
Nuclear family	8	80	8	80	
Joint family	1	10	1	10	
Extended family	1	10	1	10	
Duration of marital life					$\chi^2 = 2.571$ p = 0.276 N.S
Less than 5 years	3	30	3	30	
5-10 years	5	50	2	20	
10-15 years	2	20	5	50	
More than 15 years	-	-	-	-	
Number of children					$\chi^2 = 2.818$ p = 0.421 N.S
None	2	20	2	20	
1-2	7	70	4	40	
3-4	1	10	3	30	
More than 4	0	0	1	10	
Dietary pattern					$\chi^2 = 1.583$ p = 0.453 N.S
Vegetarian	1	10	2	20	
Non-vegetarian	9	90	7	70	
Mixed diet	-	0	1	10	

N.S: Not Significant

In the main source of information is the health personnel with more in the experimental group. Music is used for relaxation by all participants, the only relaxation tool mentioned (Table 2).

Biophysiological and Biochemical Parameters

Table 3 shows pretest biophysiological parameters for the experimental and control groups, with no significant differences across all measures (pulse rate, respiratory rate,

Table 2: Distribution of clinical variables of the adult depressive patients in the experimental and control group (N = 20)

Clinical Variables	Experimental Group (n = 10)		Control Group (n = 10)		Chi-Square value for homogeneity
	F	%	F	%	
Family history of depression					$\chi^2 = 0.000$
Yes	2	20.0	2	20.0	p = 1.000
No	8	80.0	8	80.0	N.S
History of stressful events					$\chi^2 = 0.000$
Yes	2	20.0	2	20.0	p = 1.000
No	8	80.0	8	80.0	N.S
Duration of depression					$\chi^2 = 0.952$
<less than one year	4	40.0	3	30.0	p = 0.813
1-3 years	3	30.0	4	40.0	N.S
4-6 years	2	20.0	1	10.0	
>6 years	1	10.0	2	20.0	
Number of times hospitalization					$\chi^2 = 0.667$
Once	5	50.0	5	50.0	p = 0.881
Twice	1	10.0	2	20.0	N.S
Thrice	2	20.0	2	20.0	
>Thrice	2	20.0	1	10.0	
Source of information					$\chi^2 = 4.333$
Electronic media	2	20.0	2	20.0	p = 0.228
Printed media	-	-	-	-	N.S
Family members/relations	-	-	-	-	
Friends	1	10.0	0	0	
Health personnel	7	70.0	5	50.0	
None	0	0	3	30.0	
How the client relaxes themself normally					-
Music	10	100.0	10	100.0	
Meditation	-	-	-	-	
Yoga	-	-	-	-	
Exercise	-	-	-	-	

N.S: Not Significant

Table 3: Pre-test scores of Biophysiological and Biochemical parameters among adult depressive patients between the experimental and control group (N = 20)

Physiological parameters	Experimental Group		Control Group		Mean Difference	Student Independent "t" test value	p-value
	Mean	S.D	Mean	S.D			
Pulse rate	101.60	11.95	101.60	11.95	0.00	0.00	1.000 (N.S)
Respiratory rate	23.60	3.09	23.60	3.09	0.00	0.00	1.000 (N.S)
Systolic BP	117.00	9.48	117.00	9.48	0.00	0.00	1.000 (N.S)
Diastolic BP	77.50	7.16	77.50	7.16	0.00	0.00	1.000 (N.S)
BMI	28.09	3.06	27.58	2.34	0.51	0.417	0.682 (N.S)
Serotonin	43.00	2.82	41.90	4.17	1.10	0.690	0.500 (N.S)
Oxytocin	2178.30	33.03	2143.90	106.99	34.40	0.971	0.353 (N.S)
Dopamine	5.40	1.26	5.00	1.88	0.40	0.557	0.585 (N.S)
Fasting LP	155.60	9.39	152.80	6.10	2.80	0.790	0.441 (N.S)

N.S: Not Significant, p>0.05

blood pressure, BMI, serotonin, oxytocin, dopamine, and fasting lipid profile), as confirmed by the Student's t-test (p>0.05).

Table 4 presents posttest biophysiological parameters, revealing significant differences in pulse rate (p = 0.001), respiratory rate (p = 0.016), serotonin levels (p = 0.005), and dopamine levels (p = 0.031), all showing improvement in the experimental group. No significant changes were observed in systolic/diastolic BP, BMI, oxytocin, or fasting lipid profile (p>0.05).

Level of Depression

Table 5 and Figure 1 revealed that the Light therapy showed effectiveness in the reduction of adult depression in the research study results. The depression score in the experimental group during the initial assessment averaged 19.90 (SD = 3.78) however it decreased to 14.20 (SD = 2.89) after therapy implementation resulting in a notable 5.70-point reduction (t = 4.414, p = 0.002). The participants in the control group maintained almost no changes within their depression scores (pretest: 19.00, SD = 5.37; post-test: 18.50, SD = 5.58; t = 2.236, p = 0.052).

The experimental group had substantial improvements in measurements of biophysiological and biochemical characteristics. Subjects in the experimental group displayed decreased pulse rate from 101.60±11.95 to 83.80±7.85 with p values under 0.001. At the same time their respiratory rate dropped from 23.600±3.09 to 19.60±2.27 (p<0.001). The experimental therapy caused serotonin levels to rise from 43.00±2.82 to 46.60±1.64 (p<0.001) and dopamine levels also significantly increased (p<0.001). Research using the paired 't'-test demonstrated that the experimental group experienced a substantial decrease in depression scores (p<0.001) while post-test assessment data demonstrated statistically important distinctions (p<0.05).

Table 4: Post-test scores of Biophysiological and Biochemical parameters among adult depressive patients between the experimental and control group (N = 20)

Physiological parameters	Experimental Group		Control Group		Mean Difference	Student Independent "t" test value	p-value
	Mean	S.D	Mean	S.D			
Pulse rate	83.80	7.85	101.50	11.22	17.70	4.084	0.001***
Respiratory rate	19.60	2.27	23.40	3.77	3.80	2.727	0.016*
Systolic BP	118.00	6.32	117.00	6.74	1.00	0.342	0.736 (N.S)
Diastolic BP	76.00	6.99	76.00	6.99	0.00	0.000	1.000 (N.S)
BMI	27.43	2.96	27.58	2.34	0.15	0.125	0.902 (N.S)
Serotonin	46.60	1.64	42.00	3.94	4.60	3.404	0.005**
Oxytocin	2137.50	41.62	2144.30	107.28	6.80	0.187	0.855 (N.S)
Dopamine	7.00	0.94	5.30	2.00	1.70	2.429	0.031*
Fasting LP	149.60	6.86	153.20	5.07	3.60	1.333	0.200 (N.S)

***p<0.001, *p<0.05, S: Significant, N.S: Not Significant, p>0.05

Table 5: Comparison of pre-test and post-test level of depression regarding light therapy among adult depressive patients (N = 20)

	Control Group (n = 10)		Experimental Group (n = 10)		
	Pre-Test	Post-Test	Pre-Test	Post-Test	Paired 't'test value
Mean	19.00	18.50	19.90	14.20	4.414 p = 0.052
SD	5.37	5.58	3.78	2.89	2.236 p = 0.002 S**

***p<0.001, S: Significant

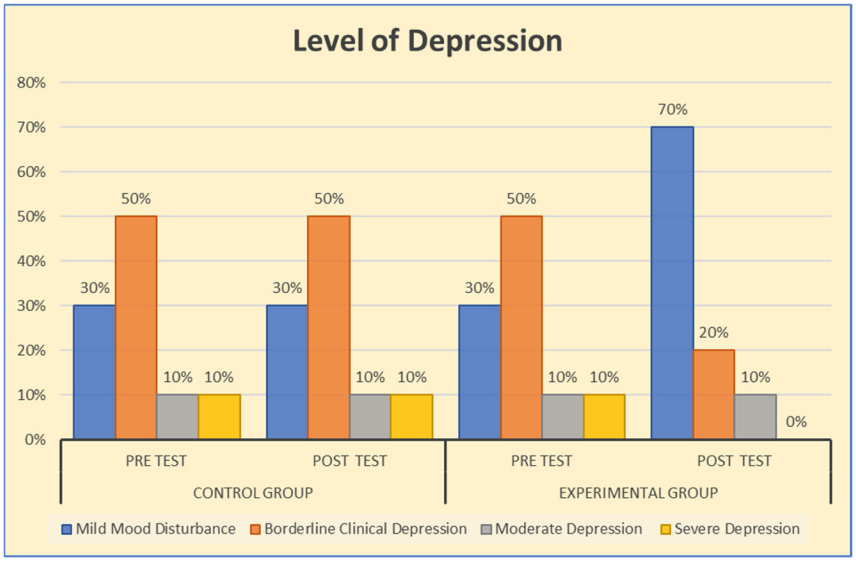

Figure 1: Pre-test and post-test level of depression

DISCUSSION

The findings from the light therapy study present significant evidence regarding the therapeutic efficacy of light exposure in reducing depressive symptoms. The experimental group demonstrated a marked reduction in depression scores, from an initial average of 19.90 (SD = 3.78) to a post-therapy average of 14.20 (SD = 2.89), indicating a substantial decrease of 5.70 points (t = 4.414, p = 0.002). These results support the effectiveness of light therapy as an intervention for patients suffering from Major Depressive Disorder (MDD). The magnitude of this change is consistent with previous studies indicating light therapy as an effective treatment modality for both seasonal and non-seasonal depression contexts [12].

In contrast, the control group exhibited minimal change in their depression scores, with pretest and post-test averages being 19.00 (SD = 5.37) and 18.50 (SD = 5.58), respectively. The non-significant reduction (t = 2.236, p = 0.052) within the control group emphasizes the critical role that light therapy plays in improving mood, suggesting that such improvement would likely not have occurred in the absence of the intervention. The significant disparity in outcomes between the experimental and control groups reinforces the assertion that light therapy provides genuine therapeutic benefits for individuals experiencing MDD. Similar conclusions have been presented in various meta-analytical reviews, affirming the clinical efficacy of light therapy, especially in augmenting mood regulation [13,14].

Beyond mood enhancement, the study revealed that light therapy positively affected several biophysiological parameters, including pulse rate and notable biochemical markers like serotonin and dopamine levels in the

experimental group, with significant improvements reported at $p<0.001$. Elevated levels of serotonin and dopamine are recognized as pivotal elements in the pathophysiology of depression and their enhancement through light exposure aligns with established research findings advocating for light therapy's role in neurotransmitter modulation [15,16].

The mechanism through which light therapy exerts its beneficial effects may be attributed to the modulation of the circadian rhythm and related neuroendocrine pathways regulating sleep, mood and overall well-being. Research suggests that exposure to bright light can advance circadian rhythms, assisting in the restoration of regular sleep patterns often disrupted in depressed individuals [17,18]. The recovery of circadian rhythm therewith can directly impact the regulation of sleep and wakefulness, essential factors in managing depressive symptoms and enhancing overall mood [19]. Specifically, the emphasis on sleep quality and regularity as light therapy outcomes corresponds with the recognition that sleep disturbances significantly contribute to depressive episodes [20,21].

Moreover, the physiological responses observed in participants undergoing light therapy resonate with findings from previous studies that highlight the extensive benefits of light exposure on health-related quality of life among depressive patients. For example, Morton et al. underscored the multifaceted outcomes associated with bright light therapy, highlighting its positive influence on both psychological and physiological health markers in patients with MDD, thereby expanding the therapeutic implications of light-based interventions [22].

The implications of these findings advocate for integrating light therapy into treatment regimens for patients suffering from MDD, especially where conventional pharmacotherapy may be less effective or linked with undesirable side effects. Evidence suggests light therapy is particularly relevant for specific demographics, such as elderly populations, where depression rates are notably high. Research has systematically examined the efficacy of light therapy in older adults, reinforcing that it may serve as an effective adjunct or alternative treatment, especially where pharmacological options pose challenges concerning tolerance or efficacy [23].

CONCLUSIONS

The study concluded that light therapy is an effective form of treatment for reducing depression scores in adult patients. The significant reduction in depression scores and improvements in biophysiological parameters in the experimental group highlight the effectiveness of light therapy in managing depressive disorders. These results validate light exposure as a therapeutic treatment for MDD and reveal its impact on mood regulation through non-invasive mechanisms. Future research should explore optimal light delivery settings, assess long-term effects and evaluate the benefits of combining light therapy with treatments like medication or psychotherapy to enhance outcomes for individuals with depression.

Acknowledgement

I would like to express my heartfelt gratitude to my guide for their unwavering support and guidance throughout this project. Their advice on what to do and what to avoid, along with their expertise and insights, played a crucial role in helping me successfully complete this project.

Conflicts of Interest

The authors declare that they have no conflict of interest for this study.

REFERENCES

[1] de Almeida, Artur Menegaz *et al.* "Bright light therapy for nonseasonal depressive disorders: a systematic review and meta-analysis." *JAMA psychiatry,* vol. 82, no. 1, October 2024, pp. 38-46. https://jamanetwork.com/journals/jamapsychiatry/article-abstract/2824482.

[2] Chan, Joey WY *et al.* "Adjunctive bright light treatment with gradual advance in unipolar major depressive disorder with evening chronotype–A randomized controlled trial." *Psychological Medicine,* vol. 52, no. 8, November 2024, pp. 1448-1457.

[3] Chen, Guanmao *et al.* "Increased functional connectivity between the midbrain and frontal cortex following bright light therapy in subthreshold depression: A randomized clinical trial." *American Psychologist,* vol. 79, no. 3, 2023, pp. 437-450. https://psycnet.apa.org/record/2024-26486-001.

[4] Chen, I-Peng *et al.* "Adjunctive bright light therapy for non-seasonal major depressive disorder: a randomized controlled trial." *International journal of environmental research and public health,* vol. 19, no. 19, September 2022. https://www.mdpi.com/1660-4601/19/19/12430.

[5] Yaodong, Chen *et al.* "Light therapy for sleep disturbance comorbid depression in relation to neural circuits and interactive hormones—A systematic review." *Plos One,* vol. 18, no. 9, September 2023. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0286569.

[6] Do, André *et al.* "Blue-light therapy for seasonal and non-seasonal depression: a systematic review and meta-analysis of randomized controlled trials." *The Canadian Journal of Psychiatry,* vol. 67, no. 10, May 2022, pp. 745-754. https://journals.sagepub.com/doi/abs/10.1177/070674372210 97903.

[7] Eisenberg, Mark J. *et al.* "Bright light therapy for depressive symptoms in hospitalized cardiac patients: A randomized controlled pilot trial." *Plos One,* vol. 15, no. 3, March 2020. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0230839.

[8] Field, Tiffany. "Seasonal affective disorder: A narrative review." *The Journal of Clinical Psychology,* vol. 2, no. 1, March 2024, pp. 1-8.

[9] Fong, Kenneth NK *et al.* "The effects of light therapy on sleep, agitation and depression in people with dementia: A systematic review and meta-analysis of randomized controlled trials." *American Journal of Alzheimer's Disease & Other Dementias,* vol. 38, March 2023. https://journals.sagepub.com/doi/full/10.1177/15333175231160682.

[10] van Hout, Lotte JE *et al.* "Treating winter depressive episodes in bipolar disorder: an open trial of light therapy." *International Journal of Bipolar Disorders,* vol. 8, June 2020. https://link.springer.com/article/10.1186/s40345-020-00182-5.

[11] Huang, Xiaodan *et al.* "A comprehensive overview of the neural mechanisms of light therapy." *Neuroscience Bulletin,* vol. 40, no. 3, August 2023, pp. 350-362. https://link.springer.com/article/10.1007/s12264-023-01089-8.

[12] Kim, Won-Hyoung *et al.* "The effect of bright light therapy on sleep and quality of life in patients with poststroke insomnia." *Psychosomatic Medicine,* vol. 84, no. 1, June 2025, pp. 123-130. https://journals.lww.com/bsam/pages/default.aspx.

[13] Liu, Yu *et al.* "PET evaluation of light-induced modulation of microglial activation and GLP-1R expression in depressive rats." *Translational psychiatry,* vol. 11, no. 1, January 2021. https://www.nature.com/articles/s41398-020-01155-z.

[14] Liu, Yu *et al.* "PET evaluation of light-induced modulation of microglial activation and GLP-1R expression in depressive rats." *Translational psychiatry,* vol. 11, no. 1, January 2021. https://www.nature.com/articles/s41398-020-01155-z.

[15] Morton, Emma *et al.* "Quality of life impacts of bright light treatment, fluoxetine and the combination in patients with nonseasonal major depressive disorder: A randomized clinical trial." *The Canadian Journal of Psychiatry,* vol. 66, no. 3, June 2020, pp. 289-297. https://journals.sagepub.com/doi/full/10.1177/0706743720936470.

[16] Nuraeni, Aan *et al.* "Efficacy of cognitive behavior therapy in reducing depression among patients with coronary heart disease: an updated systematic review and meta-analysis of RCTs." *Healthcare,* vol. 11, no. 7, March 2023. https://www.mdpi.com/2227-9032/11/7/943.

[17] Saeed, Sy Atezaz and Radhika J. Kothadia. "Bright light therapy for bipolar depression: A review of 6 studies." *Current Psychiatry,* vol. 20, no. 5, May 2021, pp. 40-46. https://cdn.mdedge.com/files/s3fs-public/CP02005040.PDF.

[18] Seok, Ji-Woo and Jung-Dae Kim. "Light therapy for older people with depressive symptoms: Systematic review and meta-analysis." *Journal of Clinical Medicine,* vol. 13, no. 22, November 2024. https://www.mdpi.com/2077-0383/13/22/6982.

[19] Trinh, Alisa *et al.* "Feasibility of adjunctive bright light therapy for depressive symptoms on an acute psychiatric floor." *Cureus,* vol. 13, no. 3, March 2021. https://www.cureus.com/articles/52933-feasibility-of-adjunctive-bright-light-therapy-for-depressive-symptoms-on-an-acute-psychiatric-floor.pdf.

[20] Volf, Carlo *et al.* "Dynamic LED light versus static LED light for depressed inpatients: results from a randomized feasibility trial." *Pilot and Feasibility Studies,* vol. 6, January 2020. https://link.springer.com/article/10.1186/s40814-019-0548-9.

[21] Wallace, Danielle A. *et al.* "Environmental bright light exposure, depression symptoms and sleep regularity." *JAMA Network Open,* vol. 7, no. 7, 2024, pp. e2422810-e2422810. https://jamanetwork.com/journals/jamanetworkopen/article-abstract/2821240.

[22] Watt, Jennifer A. *et al.* "Comparative efficacy of interventions for reducing symptoms of depression in people with dementia: systematic review and network meta-analysis." *Bmj,* vol. 372, February 2021. https://www.bmj.com/content/372/bmj.n532.abstract.

[23] Xiao, Meijuan *et al.* "The therapeutic effects and safety of bright light therapy combined with escitalopram oxalate on insomnia in patients with poststroke depression." *International Journal of Geriatric Psychiatry,* vol. 36, no. 1, August 2020, pp. 182-189. https://onlinelibrary.wiley.com/doi/abs/10.1002/gps.5412.